

Patent claims

1. A static magnetic field generating apparatus in a MR equipment, comprising:
- 5 permanent magnetic sources (1), C-type framework or a multi-posts supporting structure as the magnetic path, the measured body is positioned in the space between the two opposite end faces of the permanent magnetic sources (1), wherein the said two opposite end faces are mirror
- 10 symmetrical by the virtual plane between the two faces; pole plates (2) are placed on each of the opposite end faces, pole pieces (4) are employed beneath each of the two aforementioned pole plates, a gradient coils (7) is employed beneath each of the two pole piece (4), an RF transmitting coil (8) is employed beneath each gradient
- 15 coil (7), a first shimming ring (5) is employed outside the gradient coil (7) surrounding the gradient coil (7); each pair of the pole plates (2), pole piece (4), gradient coils (7), RF emitting coils (8) and the first
- 20 shimming rings (5) are substantially mirror symmetrical with respect to the virtual plane between the two opposite end faces; this invention has the following feature: an additional second shimming ring (6) is employed on the external edge of the each of the first
- 25 shimming rings (5), and the distance with respect to the shimming ring (5) is adjustable . The two second shimming rings (6) are essentially symmetrical by the above virtual plane.
- 30 2. A static magnetic field generating apparatus according to claim 1, characterized in that: the outer faces of the two shimming rings (6) which are facing the measured body are essentially not projecting higher than the outer plane s of the RF transmitting coils (8) to keep the
- 35 openness of the magnet.

3. A static magnetic field generating apparatus according to claim 1 or 2, characterized in that: said magnetic source comprises a plural groups of permanent magnetic columns of different magnetic energy levels, said columns are essentially distributed symmetrically to axes on the pole plane through the center point of the pole center in respect of magnetic energy level, and the magnetic energy levels of the two magnetic permanent columns which are along a line through the central point in the pole plate plane and symmetrical by the central point are identical.
4. A static magnetic field generating apparatus according to claim 3, characterized in that: the plural groups of permanent magnetic columns are axial symmetrical in respect of magnetic energy level to an axis which penetrate the central point of the pole plate plane and is vertical to the pole plate plane, and the magnetic energy levels of the two permanent magnetic columns along a ring which is centered by said central point are equal to each other.
5. A static magnetic field generating apparatus according to claim 4, characterized in that: said permanent magnetic columns are distributed on two rings, three rings, four rings or more than four rings, wherein the magnetic energy level of the permanent magnetic columns along the relatively external rings are higher than those in relatively inner rings.
6. A static magnetic field generating apparatus according to claim 4, characterized in that: said permanent magnetic columns are grouped with respect to magnetic energy level into three permanent magnetic ring areas, wherein the magnetic energy level of the external ring area is N_3 , the magnetic energy level of the middle ring area is N_2 , and the magnetic energy level of the inner ring area is N_1 , and $N_3 > N_2 > N_1$.

7. A static magnetic field generating apparatus according to any one of claims 1, 2 and 4-6, characterized in that: a plurality of magnetic inducing bolts or permanent magnetic bolts (11) are provided symmetrically along the end face axis of the permanent magnetic source (1) on one or a plurality of parts in said pole plate (2), permanent magnetic column (1), first shimming ring (5) and the second shimming ring (6), wherein said magnetic inducing bolts or permanent magnetic bolts (11) are used to adjust the static magnetic field.
8. A static magnetic field generating apparatus according to claim 3, characterized in that: a plurality of magnetic conducting bolts or permanent magnetic bolts (11) are provided symmetrically to axes on the pole plane on one or a plurality of parts in the said pole plate (2), permanent magnetic column (1), first shimming ring (5) and the second shimming ring (6), wherein the said magnetic inducing bolts or permanent magnetic bolts (11) are used to adjust the static magnetic field.
9. A static magnetic field generating apparatus in a MR equipment, comprising:
permanent magnetic sources (1), a C-type framework or a multi-posts supporting structures the magnetic path, the measured body is positioned in the space between the two opposite end faces of the permanent magnetic source (1), wherein the said two opposite end faces are mirror symmetrical by the virtual plane between the two faces; pole plates (2) are placed on each of the opposite end faces, pole pieces (4) are employed beneath each of the two aforementioned pole plates, gradient coils (7) is employed beneath each of the two pole segments (4) along the direction of the measured body, a RF transmitting coil (8) is employed beneath each gradient coil (7) along the direction of the measured body, a first shimming

ring (5) is employed outside the gradient coil (7) surrounding the gradient coil (7); each pair of the pole plates (2), pole pieces (4), gradient coils (7), RF transmitting coils (8) and the first shimming rings (5) are substantially mirror symmetrical by the virtual plane between the two opposite end faces; characterized in that: said magnetic source comprises a plural groups of permanent magnetic columns of different magnetic energy levels, and said columns are essentially symmetric in respect of magnetic energy level to axes on the pole plate plane through the central point of the pole plate plane, and a plurality of magnetic inducing bolts or permanent magnetic bolts (11) are provided symmetrically along the end face axis of the permanent magnetic source (1) on one or a plurality of parts in the said pole plate (2), permanent magnetic source (1), first shimming ring (5) and the second shimming ring (6), wherein said magnetic conducting bolts or permanent magnetic bolts (11) are used to adjust the static magnetic field.

10. Method of adjusting the static magnetic field in a MR equipment, said MR equipment comprising: permanent magnetic sources (1), a C-type framework or a multi-posts supporting structure as magnetic path, the measured body is positioned in the space between the two opposite end faces of the permanent magnetic source (1), wherein the said two opposite end faces are mirror symmetrical by the virtual plane between the two faces; pole plates (2) are placed on each of the opposite end faces, pole pieces (4) are employed beneath each of the two aforementioned pole plates, gradient coils (7) are employed beneath each of the two pole pieces (4), an RF transmitting coil (8) is employed beneath each gradient coil (7), a first shimming ring (5) is employed outside the gradient coil (7) which is surrounding the gradient coil (7); each pair of the pole plates (2), pole pieces (4), gradient coils (7), RF transmitting coils (8) and the first shimming

- rings (5) are substantially mirror symmetrical by the virtual plane between the two opposite end faces; characterized in that: employing an additional second shimming ring (6) and on the external edge of the each of the first shimming rings (5), and the two second shimming rings (6) are essentially symmetrical by the above virtual plane to uniform the static magnetic field in the space that is related to the measured body .
11. Method of adjusting static field according to claim 9, characterized in:
a plurality of magnetic conducting bolts or permanent magnetic bolts (11) are employed symmetrically or substantially symmetrical along the end face axis of the permanent magnetic source (1) on one or a plurality of parts in the said pole plate (2), permanent magnetic column (1), first shimming ring (5) and the second shimming ring (6), and by adjusting the positions of the said magnetic inducing bolts or permanent magnetic bolts (11), the field strength of the static magnetic field is adjusted.
12. Method of adjusting the static magnetic field in a MR equipment, said MR equipment comprising: a permanent magnetic source (1), a C-type framework or a multi-posts supporting structure as magnetic path, the measured body is positioned in the space between the two opposite end faces of the permanent magnetic column (1), wherein the said two opposite end faces are mirror symmetrical by the virtual plane between the two faces; pole plates (2) are placed on each of the opposite end faces, pole pieces (4) are employed beneath each of the two aforementioned pole plates, gradient coils (7) are employed beneath each of the two pole pieces (4), an RF transmitting coil (8) is employed beneath each gradient coil (7), a shimming ring (5) and the second shimming ring (6) are employed outside the gradient coil (7) surrounding the gradient coil (7);

each pair of the pole plates (2), pole pieces (4), gradient coils (7), RF transmitting coils (8) and the first shimming rings (5) are substantially mirror symmetrical by the virtual plane between the two opposite end faces; characterized in that: the permanent magnetic field source is composed of a plural groups of permanent magnetic columns of different magnetic energy levels, so that the magnetic energy level of the permanent magnetic columns further from the center of the pole plate is higher than that of the permanent magnetic columns nearer from the center of the pole plate, and thereby to improve the uniformity of the magnetic field, and meanwhile, a plurality of magnetic conducting bolts or permanent magnetic bolts (11) are employed symmetrically or substantially symmetrical along the end face axis of the permanent magnetic source (1) on one or a plurality of parts in the said pole plate (2), permanent magnetic source (1), first shimming ring (5) and the second shimming ring (6), and by adjusting the positions of the said magnetic inducing bolts or permanent magnetic bolts (11), the field strength of the static magnetic field is adjusted.